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Original Research

Glycemic Control, Self-Efficacy and Fear of Hypoglycemia Among Iranian Children with Type 1 Diabetes

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ABSTRACT

Objective: This study was designed to test the reliability of a Persian version of 2 questionnaires to assess the level of fear of hypoglycemia (FoH) and self-efficacy in diabetes management and their association with glycated hemoglobin (A1C) and parents' demographic characteristics in a sample of children with type 1 diabetes.
Design: We assessed 61 children with type 1 diabetes (35 boys and girls, 6.0 to 12.7 years of age) using the Hypoglycemia Fear Survey-Child version (HFS-C) and Self-Efficacy for Diabetes Scale-Child version (SED-C). Their glycemic control was evaluated by A1C levels.
Results: The internal consistency of the Persian version of HFS-C and SED-C were very good. Our results showed that children older than 10 years of age report lower levels of FoH, which are related to higher levels of self-efficacy ($r=-.30$, $p=0.025$ and $r=-.30$, $p=0.02$, respectively). Of the children, 42.3% of girls and 31.4% of boys reported that low blood sugar is a big problem for them. These findings suggest that FoH is a significant concern for this target group. Only 19.7% of children had controlled diabetes based on A1C levels. There was no significant association between higher A1C levels and other variables, including HFS-C, SED-C and parents' demographic characteristics.
Conclusions: The Persian version of HFS-C and SED-C are reliable and valid measures of the fear of hypoglycemia and of self-efficacy in children with type 1 diabetes, and these questionnaires could be used in our country for identifying those children who may need diabetes education and other supports. The association between greater self-efficacy and lower fear of hypoglycemia suggests that addressing self-efficacy in diabetes education courses may be effective in helping to overcome FoH.

Mots clés :
enseignement
peur/inquiétude
hypoglycémie
sentiment d'efficacité personnelle
diabète de type 1

RÉSUMÉ

Objectif : L'étude dont il est question était conçue pour tester la fiabilité des versions en langue perse de 2 questionnaires qui évaluent le degré d'inquiétude liée à l'hypoglycémie (IH) et le sentiment d'efficacité personnelle concernant la prise en charge du diabète ainsi que leur association à l'hémoglobine glyquée (A1c) et les caractéristiques démographiques des parents d'un échantillon d'enfants souffrant de diabète de type 1.
Méthodes : Nous avons évalué 61 enfants souffrant de diabète de type 1 (35 garçons et 26 filles, de 6,0 à 12,7 ans) à l'aide du HFS-C (Hypoglycemia Fear Survey-Child version) et du SED-C (Self-Efficacy for Diabetes Scale-Child version). Leur régulation glycémique était évaluée par les concentrations de l'A1c.
Résultats : La cohérence interne de la version en langue perse du HFS-C et du SED-C s'est avérée très bonne. Nos résultats ont montré que les enfants de plus de 10 ans rapportent des degrés d'IH plus faibles, qui sont reliés à des degrés du sentiment d'efficacité personnelle plus élevés ($r = -0,30$, $p = 0,025$ et $r = -0,30$, $p = 0,02$, respectivement). Parmi les enfants, 42,3 % des filles et 31,4 % des garçons ont rapporté qu'une faible glycémie représente pour eux un grave problème. Ces résultats suggèrent que l'IH est une préoccupation importante pour ce groupe cible. Seuls 19,7 % des enfants avaient maîtrisé leur diabète en fonction des concentrations de l'A1c. Il n'y a eu aucune association importante entre les concentrations de l'A1c et les autres variables, soit le HFS-C, le SED-C et les caractéristiques démographiques des parents.
Conclusions : Les versions en langue perse du HFS-C et du SED-C constituent des mesures fiables et valides de la peur de l'hypoglycémie et du sentiment d'efficacité personnelle des enfants souffrant du

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diabète de type 1. Ces questionnaires pourraient être utilisés dans notre pays pour déterminer les enfants qui auraient besoin d'enseignement sur le diabète et d'autres types de soutien. L'association entre un plus grand sentiment d'efficacité personnelle et une plus faible inquiétude liée à l'hypoglycémie suggère qu'aborder le sentiment d'efficacité personnelle au cours des séances d'enseignement sur le diabète peut contribuer de manière efficace à surmonter l'IH.

Introduction

Type 1 diabetes is usually diagnosed in childhood and adolescence, and the incidence rates are increasing worldwide, including in many parts of Asia (1). It is predicted that in European children younger than 15 years of age, the incidence will rise by 70% between 2005 and 2020 (2). Of the estimated 430 000 prevalent cases of childhood type 1 diabetes worldwide, more than one-quarter live in Southeast Asia (1).

The Diabetes Control and Complications Trial (3) and its long-term follow-up study, the Epidemiology of Diabetes Interventions and Complications (EDIC) study (4), have shown that a period of poor control can cause lasting damaging effects, even if control later improves, so it is important to aim for good control from the time of diagnosis (5).

Surveys of glycemic control in the United Kingdom, Europe and Australia have demonstrated consistently that many children and adolescents do not achieve targets for glycemic control (6–8). In children in Asia, however, there is relatively limited information available on glycemic control and management and the prevalence of diabetes complications, although high rates of microvascular and macrovascular disease have been reported in adolescents and adults (9,10). Diabcare Asia 1998 reported an overview of diabetes management and complications in patients from 230 centres in Asia but, of the 24 317 participants, only 152 (0.7%) were younger than 18 years of age. The mean glycated hemoglobin (A1C) level was higher in this younger subgroup (10.7%±3.0%) than in the whole cohort (8.6%±2.2%) (9).

Managing diabetes in children presents many challenges, especially children's inability to recognize and verbalize symptoms of high or low blood glucose and their unpredictable eating behaviours and physical activity levels, all of which make diabetes management more challenging in this age group.

Some factors that we hypothesized would affect children's glycemic control in a family framework include 1) children's fear of hypoglycemia and 2) beliefs about their abilities to manage their illness (self-efficacy) (11).

Hypoglycemia is one of the most important barriers to good glycemic control for children as well as for adults with diabetes (12). Because hypoglycemia causes unpleasant symptoms that may frighten not only the child with diabetes but also the parents, they may prefer to maintain elevated blood glucose levels to prevent hypoglycemia, which could limit attainment of glycemic targets. There is evidence that fear of hypoglycemia (FoH) may have significant negative impacts on diabetes management, metabolic control and subsequent health outcomes (13,14). Although studies have indicated that an insulin regimen involving better technology and insulin analogues may reduce the risk for hypoglycemic episodes, hypoglycemia remains a problem (15,16) and should be evaluated in children with type 1 diabetes.

An important question is whether FoH can be assessed reliably in children, and whether they can give reliable self-reports of their own FoH. There is evidence that the English-language version of a FoH survey can be completed reliably by children as young as 6 years of age (17). The evidence concerning assessment of health-related quality of life in children also indicates that children as young as 5 or 6 years of age can give reliable and valid self-reports (18–20). There is strong evidence that intrapersonal factors contribute to youths' adherence to type 1 diabetes regimens (21). Self-efficacy, or one's perceived ability to follow a diabetes treatment program, is one of the significant intrapersonal characteristics to consider in the understanding of the contributors to self-care in youth with type 1 diabetes and is an important indicator of health-behaviour changes in youth (21). Enhanced diabetes self-efficacy has been linked to improved glycemic control in older adolescents and youth (21,22). Despite the importance of self-efficacy in diabetes management, relatively little attention has been paid to its predictors and correlates, and these relationships have not been examined in pre-adolescents. Also, children's efficacy in managing their diabetes maybe associated with better management. Research concerning self-efficacy in the diabetes literature is limited (11,23,24). This study also investigated the relationship between fear of hypoglycemia and self-efficacy in youth.

Because examining child-reported psychosocial outcomes may offer important information for interventions that achieve optimal diabetes management in children with type 1 diabetes and, to the best of our knowledge, there has been no previous research or questionnaires in this field in our country, this study was designed to test the reliability of a Persian version of the Hypoglycemia Fear Survey-Behavior subscale (HFS-C) and Self-Efficacy for Diabetes Scale-Child version (SED-C).

The SED-C was used to assess whether these questionnaires can be useful tools for quick assessment of developing targeted educational interventions or not. Also, this study examined HFS-C and SED-C levels and their association with A1C and parents' demographic characteristics in a sample of children with type 1 diabetes.

Methods

Participants and procedures

Families were identified by a review of the Gabric Diabetes Education Association (http://www.gabric.ir/about/en) database from 2005 to 2012 and then contacted by a member of the research team. Parents were eligible to participate if they had a child 6 to 12 years of age who had been diagnosed with type 1 diabetes for at least 6 months. Families were excluded if the child had been diagnosed with another disease known to affect growth or other autoimmune diseases (e.g. thyroid, celiac). A total of 75 families were approached for the study, and 61 agreed to participate and were eligible (81.33% recruitment rate). Parents and children came to the office of the Gabric Diabetes Education Association, where parents provided written informed consent, then completed a diabetes history questionnaire, including an item to assess frequency of severe hypoglycemia episodes in the last 3 months. Severe hypoglycemia was defined as hypoglycemia with unconsciousness or with consciousness but needing parents' help for treatment due to mental confusion and disorientation. Children completed a battery of questionnaires, including HFS-C (both behaviour [HFS-B] and worry [HFS-W] subscales) and the SED- C to assess confidence in managing their diabetes. Children's

glycemic control was evaluated by A1C levels, which were analyzed in whole blood collected in ethylenediaminetetraacetic acid (EDTA) vacutainer tubes and measured by a designated high-performance liquid chromatography method (Tosoh G7 Automated High-performance Liquid Chromatography Analyzer; Tosoh Bioscience, Grove City, Ohio, USA). The recommended value is <8% for children and adolescents with type 1 diabetes (25). Blood samples for A1C analysis were taken on the same day when questionnaires were completed at a laboratory next to the Gabric Diabetes Education Association. The study design was cross-sectional and was approved by the medical ethical committee of Iran University of Medical Science.

Measures

Questionnaires were translated into Persian for this study using the translation process recommended by the World Health Organization (http://www.who.int/substance_abuse/research_tools/translation/en), which includes forward and backward translation, pretesting and cognitive debriefing. A total of 19 children (6 to 12 years of age) participated in the questionnaire pretesting.

Hypoglycemia fear

We used the HFS-C to assess children's worries and behaviours related to hypoglycemia (14). HFS-C is a 32-item survey that includes a 15-item worry subscale (HFS-W) and a 10-item behaviour subscale (HFS-B). Also, 7 yes-or-no questions about hypoglycemia in special situations (social, school, while alone) were asked at the end of the questionnaire. The items in the worry subscale measure anxiety-provoking aspects of hypoglycemia, and the items in the behaviour subscale measure specific behaviours to avoid hypoglycemia (14). The items are rated on a 5-point Likert scale ranging from 1 (never) to 5 (always). The HFS-C subscale scores and the total score are obtained by summing the items for, respectively, the worry subscale (range, 15 to 75), the behaviour subscale (range, 10 to 50) and the HFS-C total (range, 25 to 125) (14). Higher scores indicate higher FoH.

Self-efficacy

Children's confidence in managing their diabetes was assessed using the SED-C (26). The SED-C is a 24-item self-report measure that assesses respondents' confidence in performing daily diabetes management tasks themselves (e.g. insulin injections, figuring out meals and snacks, tracking blood sugar levels). Children respond using a 5-point Likert scale ranging from "very sure I cannot" to "very sure I can." Higher scores indicate more efficacies in diabetes management tasks. Because the SED-C is designed for and may be appropriate for children as young as 9, we prepared a guide for a trained interviewer to provide examples with adequate explanation for all children 6 to 8 years of age. Also, because of the reading level of younger children, both questionnaires (HFS-C and SED-C) were read aloud and answers were filled in by interviewer in the study.

Data analysis

Sample characteristics and HFS-C and SED-C scores were examined with descriptive statistics, including means, standard deviations (SDs) and frequencies. We used Pearson correlation analysis to compute the association between HFS-C and SED-C scores. We also used 2-tailed Pearson correlations to explore associations among children's HFS-C and SED-C scores with demographic/clinical data. Because of the importance of age and duration of diabetes in children, all of the analyses were compared across age (≤9 and ≥10 years) and diabetes duration (<24 and ≥24 months). Descriptive statistical analyses, correlations, group comparisons and Cronbach alpha reliability analyses were performed with SPSS statistical software (SPSS, Chicago, Illinois, USA). A probability value of less than 0.05 was considered statistically significant at a 95% confidence interval (CI).

Table 1
Children's demographic and clinical characteristics

	n (%)	Mean (range)	SD
Age (years)	61	9.2 (6.0–12.7)	2.0
Boys	35 (57.4)		
A1C	60	9.4 (6.1–13.7)	1.8
• Good control (<8%)	12 (19.7)		
• Less than good control (>8%)	48 (78.7)		
Duration of diabetes (months)	61	38.7 (6.0–126.0)	24.5
Total insulin dose per day (units)	61	28.3 (9.0–80.0)	14.6
Insulin type	61		
• Human	52 (85.2)		
• Analogue	9 (14.8)		
Number of insulin injections	61		
• ≤3/day	50 (82)		
• ≥4/day	11 (18)		
BG monitoring frequency per day	58		
• ≤3 times/day	33 (56.9)		
• ≥4 times/day	25 (43.1)		
Hypoglycemia (past 3 months)*	59	1.4 (0–36)	5.4

A1C, Glycated hemoglobin; *BG*, blood glucose.
* Refer to the section that discusses children's hypoglycemia with consciousness but need parent's help.

Results

The parents of 61 children (60 mothers and 45 fathers) completed the diabetes history questionnaire. Mothers were between 25 and 49 years of age (36.2±5.6), and the majority were high school graduates (65.6%) and 75% did not work outside the home. Fathers were between 30 and 58 years of age (42.0±5.9), and the majority were high school graduates (64%) and employed (94.8%).

All parents reported being of Iranian nationality. Table 1 presents the demographic and clinical characteristics of the 61 children.

The first question addressed was reliability of the Persian version of the HFS-C and SED-C in this target age. Internal consistency of the HFS-C and SED-C were calculated using the Cronbach alpha coefficient for the total scale and each subscale. The Cronbach alpha analyses of the HFS-C showed good internal consistency for the worry subscale (0.89), the behaviour subscale (0.93) and the HFS-C total (0.89). Table 2 shows the Cronbach alpha coefficient of this study compared to coefficients reported by Gonder-Frederick et al. (17). Also, results found alpha coefficients of 0.86 in children for the SED questionnaire translated into the Persian language, which showed good internal consistency.

Table 2
Cronbach alpha for children's hypoglycemia fear survey scores by age group

	Children's ages (years)			
	6 to 8*	9 to 11*	12 to 18*	Current study
n	56	51	62	61
HFS-B	0.71	0.78	0.59	0.93
HFS-W	0.89	0.87	0.89	0.89
HFS-T	0.84	0.87	0.84	0.89

HFS-B, Hypoglycemia fear-Behavior subscale; *HFS-T*, Hypoglycemia fear-Total; *HFS-W*, Hypoglycemia fear-Worry subscale.
* Cronbach alpha values reported by Gonder-Frederick et al (17) in aggregating data from several separate studies in 6- to 18-year-old persons over the past decade.

Table 3
Mean Hypoglycemia Fear Survey—Child version (HFS-C) and Self-Efficacy for Diabetes Scale-child version (SED-C) in children (aged 6 to 12.7 years) with type 1 diabetes

	Children (≤9 years)			Children (≥10 years)		
	n	Mean (range)	SD	n	Mean (range)	SD
HFS-B	31	24.8 (12–38)	7.7	30	21.4 (6–37)	7.5
HFS-W	31	31.1 (4–60)*	14.7	30	16.9 (0–43)*	11.4
HFS-T	31	55.9 (18–94)†	17.9	30	38.2 (6–75)†	16.4
SED	31	60.6 (39–84)‡	12.2	29	78.0 (35–108)‡	15.2

HFS-B, Hypoglycemia fear-behaviour subscale; *HFS-T*, Hypoglycemia fear-total; *HFS-W*, Hypoglycemia fear-worry subscale.
* $p < 0.0001$.
† $p < 0.0001$.
‡ $p < 0.0001$.

Table 3 summarizes the mean scores and SDs for the HFS-C and SED-C measures across age category (≤9 and ≥10 years). Children younger than 9 years of age had significantly higher mean HFS-W, Hypoglycemia fear-Total (HFS-T) scores than participants older than 10 year of age ($p<0.0001$). SED scores in 48.3% of children were above the midpoint cutoff (≥72). Also, children younger than 9 years of age had significantly lower mean SED scores ($p<0.0005$). There were negative correlations between the SED and the HFS-W and HFS-T scores in children ($r=-.30$, $p=0.02$ and $r=-.30$, $p=0.025$, respectively).

Table 4 summarizes the children's responses to open questions about hypoglycemia except for 1 question about hypoglycemia frequency in recent months, which is covered in the diabetes history questionnaire filled out by their parents. These results showed that children who reported significant concerns about hypoglycemia had significantly higher scores in HFS ($p<0.004$) and on the worry scale ($p<0.002$).

The mean A1C was 9.4±1.76 (range, 6.1 to 13.7), and only 19.7% of children had controlled diabetes according to recommended standards (A1C<8%). Moreover, A1C values trended higher in children 10 and older ($M=9.9$, $SD=1.8$) compared to children 9 and younger ($M=9.0$, $SD=1.7$), $F(1.\ 58)=3.79$, $p=0.05$. There was no significant association between higher A1C and other variables, including HFS-C and SED-C. No significant associations emerged between children's FoH or self-efficacy and parents' demographic characteristics (education and employment). Also, there were no significant associations between children's FoH, episodes of severe hypoglycemia in the past 3 months and glycemic control.

Discussion

The current study examined Iranian children's fear of hypoglycemia and their self-efficacy in managing their diabetes. Most previous studies in this area, with only a few exceptions (14,27), have focused exclusively on parental FoH and SED. To investigate fear of hypoglycemia and self-efficacy in Iranian children, this study developed Persian translations of the HFS-C and SED-C.

Table 4
Reported hypoglycemic episodes in special situations in children with type 1 diabetes

	Girls		Boys	
	Yes n (%)	No n (%)	Yes n (%)	No n (%)
Is low blood sugar a big problem for you?	11 (42.3)	15 (57.7)	11 (31.4)	24 (68.6)
Have you ever passed out due to hypoglycemia?	12 (46.2)	14 (53.8)	9 (25.7)	26 (74.3)
Have you ever had a hypoglycemic episode while asleep?	16 (61.5)	10 (38.5)	29 (82.9)	6 (17.1)
Have you ever had a hypoglycemic episode while you were awake but by yourself?	14 (53.8)	12 (46.2)	16 (45.7)	19 (54.3)
Have you ever had hypoglycemia in front of friends or strangers?	16 (61.5)	9 (34.6)	23 (65.7)	12 (34.3)
Have you ever had hypoglycemia when you were at school?	19 (73.1)	4 (15.4)	25 (71.4)	6 (17.1)

In comparison with the Cronbach alpha values reported by Gonder-Frederick et al (17) in aggregated data from several separate studies of 6- to 18-year-old youth, our data indicate good internal consistency for the HFS-C questionnaire, which replicates their internal consistency for this target age group (17). The results of the Green et al study also support the internal consistency and test-retest reliability of the HFS in youth (27). Also, the translated SED-C used to assess children's confidence in managing their diabetes showed alpha coefficients comparable to those reported by Greyet al (28) for adolescents (0.88). These acceptable alpha coefficients for the Persian version of the HFS-C and SED-C indicate that these questionnaires are reliable instruments, could be used in our country and could provide useful tools for assessing levels of FoH and self-efficacy in children with type 1 diabetes so as to help identify those children who may need diabetes education and other important support.

Our study showed higher FoH and worry about hypoglycemia in children who reported that hypoglycemia was a problem for them. These findings suggest that FoH is a significant concern for these children with type 1 diabetes. A total of 42.3% of girls and 31.4% of boys reported that hypoglycemia is a problem for them, and more than 60% of girls and boys reported they had had a hypoglycemic episode in front of friends or strangers and at school. This may indicate that Iranian children with diabetes are afraid to be seen having a hypoglycemic episode in these situations and that this is a cultural issue that should be addressed in education programs. Although some level of fear is normal and adaptive and could help motivate children and their parents to protect them from hypoglycemic episodes, extreme FoH might lead to poorer coping strategies, such as overeating to preventing low blood glucose, administering lower doses of insulin and feeding children without administering insulin, subsequently leading to inadequate insulin doses and declining glycemic control (29).

On the other hand, the majority of these young people attend school and need knowledgeable staff to provide safe school environments, especially because of serious events like hypoglycemia that need urgent help. Appropriate diabetes care in the school and daycare setting is necessary for the children's immediate safety, long-term well-being and optimal academic performance (30).

In contrast to the findings of another study that suggested worries about hypoglycemia were relatively lower in younger-aged school children with type 1 diabetes but then increased to a plateau by the time children were approximately 9 years of age (17), our results showed lower levels of HFS-W and HFS-T in children older than 10 years of age, which is likely to be related to higher levels of SED-C or may be due to an over-reporting of fear by younger children instead of real fear of hypoglycemia. Increased knowledge by educating diabetes self-management tasks could result in alleviating FoH and may result in better glycemic control.

Studies have not produced consistent results about the impact of FoH on glycemic control, with some finding an association between higher levels of FoH and poorer diabetes control (31,32) and others not finding this relationship (33–35). Our data did not identify any association between FoH, self-efficacy and glycemic control. The reasons for this result are unclear. Perhaps the relationship between FoH, self-efficacy and diabetes control is not linear and is more complex. Also, there are other factors that have influences on A1C. But it is still important to identify children with high FoH (17) and to address their needs in patient-education programs.

Gonder-Frederick et al reported that FoH was not related to metabolic control in a sample of adolescents, but adolescents who

had experienced recent severe hypoglycemia with unconsciousness had significantly higher A1C levels (14). These authors also showed that the frequency of severe hypoglycemic episodes was a significant predictor of FoH in adolescents (14). Other studies have also failed to find a relationship between parental FoH and hypoglycemia history (14,36,37). In the current study, neither FoH nor self-efficacy in youth correlated with number of hypoglycemia episodes in past 3 months. Also, higher frequencies of hypoglycemia episodes in the past 3 months did not significantly correlate with A1C levels. Perhaps a relationship would have been found with a more detailed assessment of hypoglycemia episodes in the past 3 months like that conducted in studies by Haugstvedt et al (38) and Patton et al (36) in adult groups. It may also be that the qualitative characteristics of hypoglycemia experiences (e.g. the level of associated distress and trauma) may have more influence than the quantitative frequencies of episodes in the development of FoH (17).

Glycemic control was poorer in children older than 10 years of age; however, they had higher self-efficacy and lower FoH. Poorer metabolic control maybe due either to the beginning physiologic changes of puberty, which contribute to insulin resistance, or to behavioural factors. Further research is necessary to understand these factors better.

No relationship was found between parental demographic factors and children's questionnaire scores. However, the size of the sample may not have been large enough for a significant association to emerge between parental education and employment status and children's FoH or self-efficacy. Also, there may have not been enough variability in the sample for these demographic variables.

Limitations

The findings of this study should be considered within the context of several limitations. First, because of the relatively small sample size and the selection of children from a database, the findings of this study cannot be generalized to the whole Iranian pediatric diabetes community. Second, with the cross-sectional design, there is no way to know conclusively which is the most accurate direction for these associations. Also, the SED-C questionnaire was not originally designed for the youngest group of children and thus needed to be administered with some modifications.

Conclusions

This is the first study to measure specifically the FoH and self-efficacy of Iranian children with type 1 diabetes. Our results indicate that the Persian versions of the HFS-C and SED-C are psychometrically valid and reliable instruments to measure FoH and self-efficacy in managing diabetes in this target group. Furthermore, findings indicate that higher levels of self-efficacy likely go hand-in-hand with lower worry and concern about experiencing hypoglycemia. Therefore, children may benefit from diabetes education, counselling and problem-solving training to improve their self-efficacy and to prepare them for better management of their diabetes, including hypoglycemia.

Important implications for diabetes education based on the findings in the current study are recognizing diabetes-related fear and self-efficacy in children with type 1 diabetes and addressing children more seriously in diabetes education programs. Structured education courses for all age groups of children, as well as their parents, that include a focus on FoH and self-efficacy may help to maintain ongoing parent-child collaborations and achieve better diabetes management under the supervision of their parents in Iranian children with type 1 diabetes.

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Author Contributions

All authors contributed to the conception and design of the study, the analysis and interpretation of the data and the drafting of the manuscript and gave final approval of the version to be submitted.

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